PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference BP106723	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/FI 2003/000529	International filing date (day/month/year) 30-06-2003	Priority date (day/month/year)
International Patent Classification (IPC) or national classification and IPC H04L 23/26		

Applicant
NOKIA CORPORATION ET AL

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of __3__ sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

   a. ☒ *(sent to the applicant and to the International Bureau)* a total of __4__ sheets, as follows:

      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).

      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s))

      _____ , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

   ☒ Box No. I   Basis of the report

   ☐ Box No. II   Priority

   ☐ Box No. III   Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   ☐ Box No. IV   Lack of unity of invention

   ☒ Box No. V   Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   ☐ Box No. VI   Certain documents cited

   ☐ Box No. VII   Certain defects in the international application

   ☐ Box No. VIII   Certain observations on the international application

Date of submission of the demand 18-03-2004	Date of completion of this report 06-04-2005
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Form PCT/IPEA/409 (cover sheet) (January 2004)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI 2003/000529

Box No. I	Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on a translation from the original language into the following language _____ , which is the language of a translation furnished for the purposes of:

    ☐ international search (under Rules 12.3 and 23.1(b))

    ☐ publication of the international application (under Rule 12.4)

    ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

    ☐ the international application as originally filed/furnished

    ☒ the description:

        pages   __1-12_____ as originally filed/furnished

        pages* _____ received by this Authority on _____

        pages* _____ received by this Authority on _____

    ☒ the claims:

        pages   _____ as originally filed/furnished

        pages* __13-16_____ as amended (together with any statement) under Article 19

        pages* _____ received by this Authority on _____

        pages* _____ received by this Authority on _____

    ☒ the drawings:

        pages   __1-11_____ as originally filed/furnished

        pages* _____ received by this Authority on _____

        pages* _____ received by this Authority on _____

    ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

    ☐ the description, pages _____

    ☐ the claims, Nos. _____

    ☐ the drawings, sheets/figs _____

    ☐ the sequence listing *(specify)*: _____

    ☐ any table(s) related to the sequence listing *(specify)*: _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

    ☐ the description, pages _____

    ☐ the claims, Nos. _____

    ☐ the drawings, sheets/figs _____

    ☐ the sequence listing *(specify)*: _____

    ☐ any table(s) related to the sequence listing *(specify)*: _____

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

Form PCT/IPEA/409 (Box No. I) (January 2004)

Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-24	YES
	Claims		NO
Inventive step (IS)	Claims	1-24	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-24	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:
D1: WO0169878 A1
D2: EP0837582 A2
D3: EP0955754 A1
D4: WO9917493 A1
D5: US5848107 A
The cited documents represent the general state of the art.
The invention defined in claims 1-24 is not disclosed by any of these documents.
The cited prior art differ from the claimed invention in that neither of the documents describe a method and apparatus for receiving a multi-carrier signal where according to the claims, the energy of pilot carriers is taken into consideration. Therefore, the claimed invention is not obvious to a person skilled in the art.
Accordingly, the invention defined in claims 1-24 is novel and is considered to involve an inventive step. The invention is industrially applicable.

Claims

1.   A method for receiving a multi-carrier signal, the method comprising the steps of:

defining an energy of pilot carriers in said signal in respect of an estimated guard in-
terval position of said signal, and

based on said energy, selecting a position for a time domain to frequency domain
transform window of said signal.

2.   A method according to claim 1, wherein the step of defining comprises:

defining the energy of said pilot carriers in said signal in respect of the estimated
guard interval position of said signal for predetermined amount of trial positions for
said time domain to frequency domain transform window,

and further the step of selecting further comprises:

selecting said position from said trial positions.

3.   A method according to claims 1 or 2, wherein the selection step comprises: se-
lecting said position for the time domain to the frequency domain transform win-
dow of said signal in such a way that the smallest amount of inter symbol interfer-
ence is formed.

4.   A method according to any of the preceding claims, wherein said step of se-
lecting is based on energy outside the estimated guard interval position having the
minimum.

5.   A method according to any of the preceding claims, wherein said step of se-
lecting is based on energy inside the estimated guard interval position having the
maximum.

6.   A method according to any of the preceding claims, wherein said step of se-
lecting is based on an energy ratio between energy sample inside the estimated
guard interval position and energy sample outside the estimated guard interval posi-
tion.

7.   A method according to claim 1, further comprising, before the step of defin-
ing, the step of:

performing a coarse timing for said signal for an initial position for said time domain to frequency domain transformation window.

8.   A method according to claim 1, wherein the step of defining is performed according to a predetermined scheme for determining a predetermined amount of trial positions for said time domain to frequency domain transform window, and

based on said energy, selecting the time domain to frequency domain transformation window from said trial positions in such a way that the smallest amount of inter symbol interference is formed.

9.   A method according to any of the preceding claims, further comprising the step of

performing a fine timing with the selected time domain to frequency domain transformation window for fine tuning said selected time domain to frequency domain transformation window.

10.   A method according to claim 1, further comprising, before the step of defining, the steps of:

performing a first time interpolation for said signal,

further, before the step of selecting,

taking a certain amount of trial positions for said time domain to frequency domain transformation window in accordance with a predefined scheme,

and further,

based on said energy, selecting the time domain to frequency domain transformation window position of said trial positions with the smallest amount of interference,

initialising a second time interpolation with the selected position, and

fine tuning said time domain to frequency domain transformation window.

11.   A method according to claim 10, wherein said first time interpolation comprises a linear time interpolation.

12.   A method according to any of the preceding claims, wherein said time domain to frequency domain transform window of said signal comprises FFT-window.

13. A method according to any of the preceding claims, wherein said multi-carrier signal comprises a mobile IP over DVB-T signal.

14. A method according to any of the preceding claims, wherein said pilot carriers are scattered pilot carriers.

15. Data processing system comprising means for carrying out the method according to claim 1.

16. A computer program comprising computer program code means adapted to perform the method of claim 1 when said program is run on a computer.

17. A computer program as claimed in claim 16 embodied on a computer readable medium.

18. A computer readable medium comprising program code adapted to carry out the method of claim 1 when run on a computer.

19. A carrier medium carrying the computer executable program of claim 16.

20. A receiver for receiving a multi-carrier signal, the receiver comprising:

means for defining an energy of pilot carriers in said signal in respect of an estimated guard interval position of said signal, and

based on said energy, means for selecting a position for a time domain to frequency domain transform window of said signal.

21. A receiver according to claim 20, wherein said means for defining comprises a fine timing unit.

22. A receiver according to claim 20, wherein said means for selecting comprises a fallback unit for tracking predetermined trial positions for time domain to frequency domain transform window and a control unit for selecting the position from said trail positions.

23. A system for receiving a multi-carrier signal, the system comprising:

means for determining a predetermined amount of trial positions for FFT-window according to a predetermined scheme,

means for defining energy for each trial position in respect of an estimated guard interval position of said signal, and

means for selecting a position from said trial positions for said FFT-window in such a way that the smallest amount of interference is formed for a desired signal.

5   24.   A method for receiving an OFDM radio signal, comprising the steps of:

(a) receiving said signal,

(b) selecting an initial position for a FFT-window of said signal in accordance with a coarse timing,

(c) performing FFT to said initial position to obtain a first output,

10   (d) extracting scattered pilots from said first output to obtain a second output,

(e) performing a linear time interpolation for said second output,

(f) performing IFFT for the time interpolated scattered pilots for obtaining a channel impulse response (CIR),

(g) estimating energy based on the CIR,

15   (h) keeping track on used trial positions with said energy,

(i) changing FFT-window position in accordance with a predefined scheme until predefined amount of trial positions for said FFT-window have been applied,

(j) selecting a FFT-window from said trial positions,

(k) performing a time interpolation for the scattered pilots based on the selected
20   FFT-window,

(l) performing IFFT for the time interpolated scattered pilots, and

(m) fine tuning the selected FFT-window in accordance with the IFFT.

Claims

1.   A method for receiving a multi-carrier signal, the method comprising the steps of:

5   defining an energy of pilot carriers in said signal in respect of an estimated guard interval position of said signal, and

based on said energy, selecting a position for a time domain to frequency domain transform window of said signal.

2.   A method according to claim 1, wherein the step of defining comprises:

defining the energy of said pilot carriers in said signal in respect of the estimated
10   guard interval position of said signal for predetermined amount of trial positions for said time domain to frequency domain transform window,

and further the step of selecting further comprises:

selecting said position from said trial positions.

3.   A method according to claims 1 or 2, wherein the selection step comprises: se-
15   lecting said position for the time domain to the frequency domain transform window of said signal in such a way that the smallest amount of inter symbol interference is formed.

4.   A method according to any of the preceding claims, wherein said step of selecting is based on energy outside the estimated guard interval position having the
20   minimum.

5.   A method according to any of the preceding claims, wherein said step of selecting is based on energy inside the estimated guard interval position having the maximum.

6.   A method according to any of the preceding claims, wherein said step of selecting
25   lecting is based on an energy ratio between energy sample inside the estimated guard interval position and energy sample outside the estimated guard interval position.

7.   A method according to claim 1, further comprising, before the step of defining, the step of:

performing a coarse timing for said signal for an initial position for said time domain to frequency domain transformation window.

8. A method according to claim 1, wherein the step of defining is performed according to a predetermined scheme for determining a predetermined amount of trial positions for said time domain to frequency domain transform window, and

based on said energy, selecting the time domain to frequency domain transformation window from said trial positions in such a way that the smallest amount of inter symbol interference is formed.

9. A method according to any of the preceding claims, further comprising the step of

performing a fine timing with the selected time domain to frequency domain transformation window for fine tuning said selected time domain to frequency domain transformation window.

10. A method according to claim 1, further comprising, before the step of defining, the steps of:

performing a first time interpolation for said signal,

further, before the step of selecting,

taking a certain amount of trial positions for said time domain to frequency domain transformation window in accordance with a predefined scheme,

and further,

based on said energy, selecting the time domain to frequency domain transformation window position of said trial positions with the smallest amount of interference,

initialising a second time interpolation with the selected position, and

fine tuning said time domain to frequency domain transformation window.

11. A method according to claim 10, wherein said first time interpolation comprises a linear time interpolation.

12. A method according to any of the preceding claims, wherein said time domain to frequency domain transform window of said signal comprises FFT-window.

13. A method according to any of the preceding claims, wherein said multi-carrier signal comprises a mobile IP over DVB-T signal.

14. A method according to any of the preceding claims, wherein said pilot carriers are scattered pilot carriers.

15. Data processing system comprising means for carrying out the method according to claim 1.

16. A computer program comprising computer program code means adapted to perform the method of claim 1 when said program is run on a computer.

17. A computer program as claimed in claim 16 embodied on a computer readable medium.

18. A computer readable medium comprising program code adapted to carry out the method of claim 1 when run on a computer.

19. A carrier medium carrying the computer executable program of claim 16.

20. A receiver for receiving a multi-carrier signal, the receiver comprising:

means for defining an energy of pilot carriers in said signal in respect of an estimated guard interval position of said signal, and

based on said energy, means for selecting a position for a time domain to frequency domain transform window of said signal.

21. A receiver according to claim 20, wherein said means for defining comprises a fine timing unit.

22. A receiver according to claim 20, wherein said means for selecting comprises a fallback unit for tracking predetermined trial positions for time domain to frequency domain transform window and a control unit for selecting the position from said trail positions.

23. A system for receiving a multi-carrier signal, the system comprising:

means for determining a predetermined amount of trial positions for FFT-window according to a predetermined scheme,

means for defining energy for each trial position in respect of an estimated guard interval position of said signal, and

means for selecting a position from said trial positions for said FFT-window in such a way that the smallest amount of interference is formed for a desired signal.

5   24.   A method for receiving an OFDM radio signal, comprising the steps of:

(a) receiving said signal,

(b) selecting an initial position for a FFT-window of said signal in accordance with a coarse timing,

(c) performing FFT to said initial position to obtain a first output,

10   (d) extracting scattered pilots from said first output to obtain a second output,

(e) performing a linear time interpolation for said second output,

(f) performing IFFT for the time interpolated scattered pilots for obtaining a channel impulse response (CIR),

(g) estimating energy based on the CIR,

15   (h) keeping track on used trial positions with said energy,

(i) changing FFT-window position in accordance with a predefined scheme until predefined amount of trial positions for said FFT-window have been applied,

(j) selecting a FFT-window from said trial positions,

(k) performing a time interpolation for the scattered pilots based on the selected
20   FFT-window,

(l) performing IFFT for the time interpolated scattered pilots, and

(m) fine tuning the selected FFT-window in accordance with the IFFT.